Energy Management for Commercial Buildings

A Manual for Owners and Managers

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Energy Management for Commercial Buildings

Province of British Columbia

Ministry of Energy, Mines and Petroleum Resources

ENERGY CONSERVATION AND TECHNOLOGY DIVISION

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Introduction

This manual is for people who are in the business of buildings. It shows the potential for existing buildings to save energy and money, and it explains how to set up an energy management program.

While this information is primarily for large high-rise office buildings, it also applies to most commercial buildings.

But why be interested at all? Because energy efficiency makes good business sense. Businessmen everywhere are catching on. British Columbia's forest industry, for example, is moving quickly to energy self-sufficiency by turning its wood wastes into energy. Energy utilities are beginning to subsidize their customers' home re-insulation because saving energy is cheaper than wasting it, and having to develop new and more expensive sources.

Take cars as another example. In their advertising, many auto manufacturers are now stressing energy efficiency above all other factors. Some auto companies are finding that they are now in economic trouble for not getting on the conservation bandwagon earlier.

The same thing could happen to commercial buildings. Energy is one of the few areas where you can cut down expenses and increase your building's desirability, both in terms of comfort and rent. In short, energy efficiency can protect or enhance your competitive position. Already, new high-rise buildings are far more energy efficient than those built in the 1960's and 70's. But these older buildings will have to compete in a market of increasingly energy-aware consumers.

This manual will help you start on a program to keep your building from becoming an energy "dinosaur," like the outmoded gas guzzling cars now on their way to the wrecking yards. Best of all, you can prevent this from happening to you with little or no capital investment.

WHERE ENERGY PRICES ARE GOING

Up. And probably, like for the past decade, at a rate faster than just about everything else. That means your building's energy costs become more and more critical to your competitive edge every day.

So far, we in western Canada have been shielded from the worst effects of increasing energy prices. But we are not immune.

The so-called energy crisis does not mean that our energy supply is suddenly ending. It does mean that we face a transition, sometimes difficult, to different energy supplies and higher prices. Oil and gas are finite resources. As they are depleting, they are becoming more expensive. In B.C. we are lucky to have relatively abundant natural gas resources, but even these will rise in price. Additionally, electricity will increase in cost as the higher costs of new generation facilities are added into base rates. New technology, such as solar energy and coal liquifaction, will help our supply situation. But they will take more research to develop.

So energy will take a larger and larger chunk of everyone's budget. Clearly, it's going to pay to be as energy efficient as possible.

Summary

This section summarizes the contents of the manual. If you prefer the more detailed version first, you may wish to skip this section and go right to the next.

THE POTENTIAL FOR SAVINGS

Most existing office buildings use up to three or four times more energy than new buildings designed for energy efficiency. Existing buildings can, however, be economically retrofitted (modified) to reduce their energy consumption by as much as 30 to 60 percent. With reduced expenditures of this magnitude, these buildings can remain competitive in the rental market.

THE ENERGY MANAGEMENT PROGRAM

The manual outlines a four-part management program:

1. EVALUATING ENERGY USE

Energy Consumption Records

Regular records of your building's energy consumption will allow comparison of its performance per square metre to other buildings or to target levels. You will also be able to monitor the progress and value of your energy management program.

Energy Audit

In-house technical staff or consultants should conduct a detailed audit to identify where your building is wasting energy, what measures will cut these losses, and what investment is necessary.

2. UPGRADING OPERATION AND MAINTENANCE PROCEDURES

Whether or not physical changes are feasible for your building, upgrading operation and maintenance procedures, at little or no cost, can achieve substantial energy savings.

Operation

Energy should be used only when needed. Systematic operational procedures (manual and/or automatic) should be set up for the scheduling and control of all lighting, heating, ventilation and air conditioning systems. This includes lower winter and higher summer temperature settings, as well as night and weekend shutdown or set back.

Maintenance

A building staff that is aware and trained in energy efficiency can make considerable savings through a regular program of preventative maintenance of equipment and facilities.

3. REDUCING ENERGY LOADS

Several types of loads make up a building's energy use. This section explains each of these loads and shows the potential for energy savings.

Building Enclosure

A building's heating and cooling needs are affected by how much heat is transmitted through walls and windows, and also by how much air infiltrates into and out of the building. While air leakage can be reduced by weatherstripping and other minor repairs, re-insulation to control transmission losses may be economic only at the same time as other major renovations are carried out.

Ventilation

Most buildings mechanically take in more fresh air than is necessary for adequate comfort. More appropriate intake rates greatly reduce the energy load necessary to heat and cool the fresh air.

Summary

Lighting

Lighting has a double energy load; directly for illumination and indirectly in the cooling required to counteract the heating effect of lights. Most buildings are overlit, so it pays to remove a portion of the lighting fixtures, particularly in non-work areas.

Other

The factors which make up the rest of a building's energy consumption are office and other equipment, hot water heating, and equipment for moving people and goods (e.g. elevators).

4. IMPROVING MECHANICAL SYSTEMS

Heating, Ventilation and Air Conditioning Systems

Heating, ventilation and air conditioning loads should be viewed as one system. Most of these systems use energy very inefficiently because their operations require simultaneous heating and cooling. While it may not be practical for some buildings to install newer systems that eliminate this problem, most existing systems can still be adjusted to run far more efficiently.

Heat Recovery Systems

Various systems are available for capturing the waste heat from a building's occupants, lighting and equipment, and redirecting that energy to satisfy all or part of the building's space heating load. These systems are particularly economic for new buildings.

FINANCING ENERGY MANAGEMENT

The energy savings resulting from retrofit improvements usually pay back the required capital investment in one to three years. But the terms of most tenant leases may discourage owners from financing these improvements. This section presents a practical formula for arranging a special owner/tenant agreement whereby the tenant agrees to a freeze in his energy charges over one to three years. The retrofit program can then be financed because the energy savings in the first one to three years will go to the owner instead of the tenant.

NEW BUILDINGS

Costs

Also discussed is the advisability of using life cycle costing to determine the real cost of a new building, including its long-term energy consumption.

APPENDICES

Operation and Maintenance Checklist

Sample Energy Consumption Record Forms 1, 2, 3.

The Energy Bus Program.

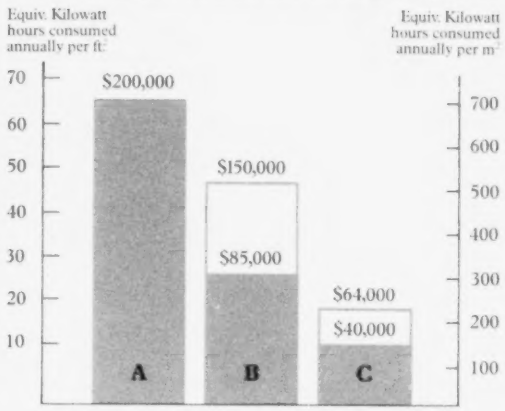
The Potential for Savings

The best way to see the potential for energy savings is to recognize that large commercial buildings vary considerably in the amount of energy they consume. As shown in the accompanying diagram, the annual energy costs for an average office building in the B.C. Lower Mainland are three to four times greater than that possible in a more efficient new building.

Unfortunately, most existing buildings were not designed with energy efficiency as a major factor. Appearance, function, comfort and initial capital cost were all considered to be far more important. Not that energy efficiency would have meant sacrificing these other values. It was simply that energy seemed cheap enough to be all but ignored.

Now that energy can't be ignored, the less efficient existing buildings run the risk of becoming obsolete. As energy prices continue to rise, these buildings will become increasingly less competitive.

Comparison of Energy Use and Cost in Existing, Retrofitted and New Buildings



Building A: The energy used by the average of 24 office buildings in the Lower Mainland included in a recent B.C. Hydro survey.

Building B: The range of energy use attainable in an existing building following capital improvements with an average pay back of two years. Building B also practises a cost saving program of efficient operation and maintenance.

Building C: The range of energy use attainable in a new building designed for energy efficiency. The higher level of energy use shown in Building C requires little or no additional capital investment.

Note: The costs shown are estimates of the annual energy cost, based on 1978 B.C. Hydro rates, for a 20,000 m^2 gas-heated building. With higher prices and with rates that increasingly reward lower energy use, the cost differentials between these three examples will widen over the years, and inefficient buildings will become increasingly less competitive.

Fortunately, as also shown in the previous diagram, most buildings can, with a relatively small investment, be retrofitted (modified) so that their energy cost is reduced by as much as 30 to 60 percent. The range of energy use shown for Building B is a reasonable target level to which existing buildings should aim to reduce their consumption.

Energy Management Program

The energy management program described below consists of four parts:

1. Evaluating energy use.
2. Upgrading operation and maintenance procedures.
3. Reducing energy loads.
4. Improving mechanical systems.

Not all the recommendations described will apply to every building. For example, while most buildings can profit from improved operation and maintenance, the costs of specific capital improvements may or may not be justified.

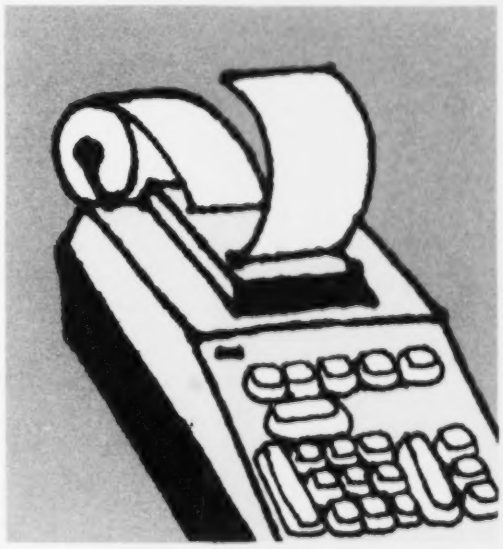
Nevertheless, it is recommended that all possible improvements be given full consideration. The savings potential in your building is probably greater than you might at first suppose.

Evaluating Energy Use

Energy Consumption Records

The first step in evaluating energy use is to set up and maintain a simple record of your building's complete energy consumption. This record will allow you to:

- Determine how much energy your building is using annually per square metre (or foot).
- Compare your building's performance to other buildings or to a target level of energy consumption. (For example, that shown for the retrofitted building in the diagram on page 5).
- Identify periods when energy use is high.
- Monitor the success of your energy management program by comparing present consumption to the lower levels achieved in subsequent years.



Sample record sheets are included at the back of this manual, including instruction for filling them out. Keeping these records should become an integral part of your overall management policy because they will clearly show how you are saving energy and money year by year.

Energy Audit

Depending on your building's size and your own financial capability, it is recommended that experienced technical personnel from your staff or, more likely, qualified professional consultants carry out a detailed audit of your building's energy performance.

The purpose of this audit is to:

- Evaluate in detail the energy efficiency of your building's physical structure and its electrical and mechanical systems.
- Identify specific energy-saving measures, and for each one indicate:

1. Amount of energy-saving potential.
2. Amount of money-saving potential.
3. Capital investment required, if any.
4. Pay-back period.

The information from this audit will enable you to judge for yourself the value of establishing an energy management program. It will also serve as the specific operational plan for that program. Most of the items covered in the remainder of this section, the Energy Management Program, should be included in your building's energy audit.

Upgrading Operation and Maintenance Procedures

Operation and maintenance are essential to the success of any energy management program, even in the most efficient building. Upgraded operation and maintenance procedures alone can save as much as 10 to 25 percent on energy consumption.

Like building design itself, operation and maintenance were previously defined primarily by the needs of comfort, attractiveness and cost. All that's required now is the recognition that energy efficiency must also become a principal factor.

Operation

Efficient operation means using energy only when it is needed. Turning off lights and unused equipment, and lowering thermostats in winter and raising them in summer are straightforward ways of reducing energy waste. But in commercial buildings, even greater savings can be achieved by establishing precise operational procedures for the appropriate scheduling of all lighting, heating and ventilation systems.

This requires the institution of night and weekend schedules for setting back temperatures, closing down outside air dampers, and shutting down exhaust fans. In smaller buildings operation personnel may need to carry out these schedules using manual controls. Many larger buildings, however, already have some automatic timing controls. In most cases, these can be re-programmed for greater efficiency, or more effective controls can be installed.

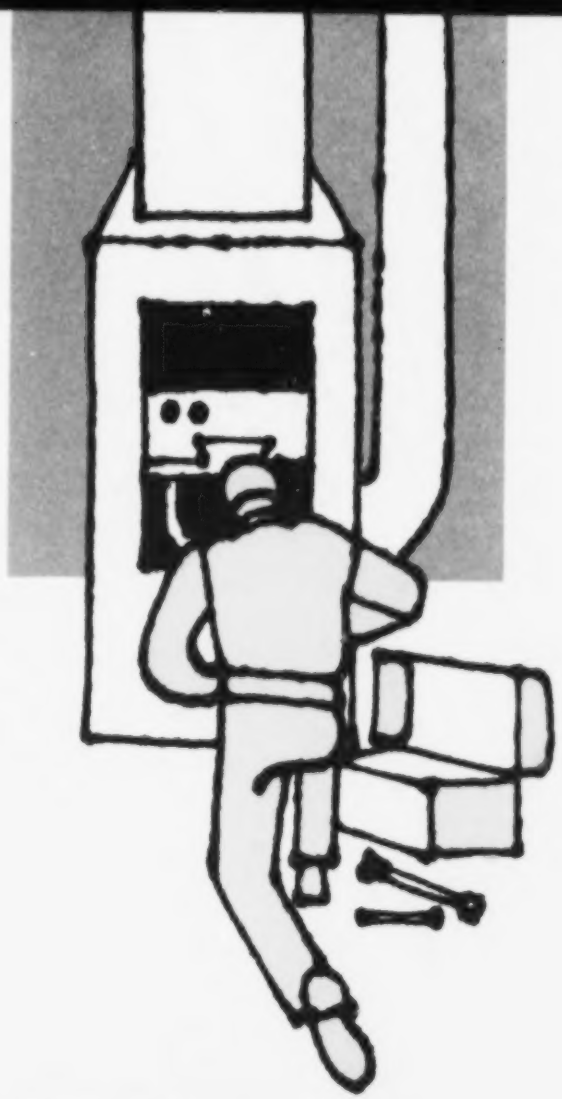
Maintenance

A regular program of preventative maintenance prolongs the life of equipment and saves energy. The key to a successful program is a trained and committed staff.

To begin with, one person should be given overall responsibility for your building's energy management program. This person is likely to be the head of the maintenance department. But whoever is chosen should be well qualified.

Next, target goals for energy reduction might be set. The entire maintenance staff should be aware of the program, and those participating should be familiar with energy-related equipment. Personnel should also be encouraged to upgrade their skills and should be rewarded by promotion or other incentives. The benefits of improved maintenance will easily repay any added cost.

The initial energy audit, described earlier in the manual, will probably pinpoint problem areas that need particular maintenance and care. In general, regular attention should be given to those systems



or equipment whose inadequate adjustment or breakdown will cause excessive energy consumption. This includes, for example, boilers, automatic temperature controls, and ventilation devices. With very complicated control systems, however, maintenance contracts with specialized companies may be necessary.

The checklist at the back of this manual contains a more extensive list of recommended operation and maintenance procedures.

Reducing Energy Loads

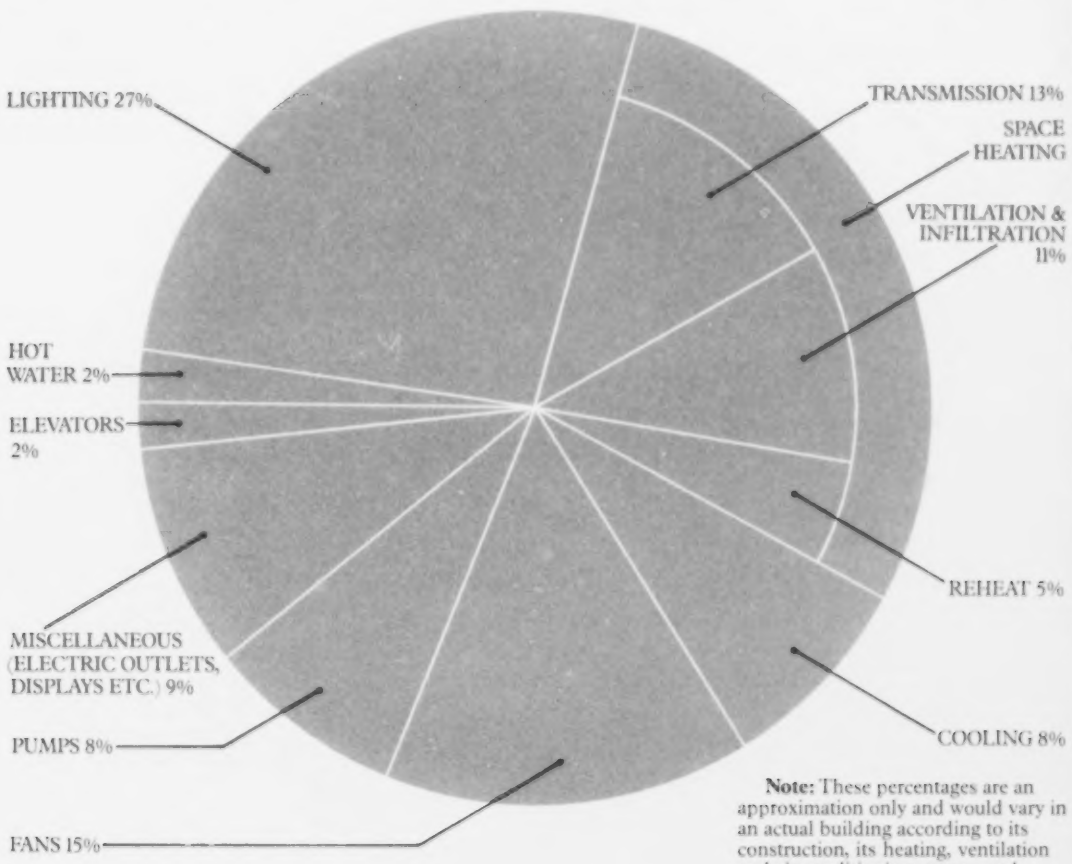
The energy consumption of a building is made up of several different sources, called energy loads (see the accompanying diagram). These loads are described below along with an explanation of the potential for energy savings.

Building Enclosure

Heat transmission and air infiltration are two of the principal ways that a building's structural enclosure affects energy consumption. The amount of insulation and the type and amount of window area determine how much wanted or unwanted heat is transmitted into or out of a building.

Air infiltration, on the other hand, is determined largely by a building's tightness and the nature of the structural materials with which it was constructed. Air leakage includes both unwanted air coming in and heated or cooled air lost to the outside, as, for example, through elevator shafts.

Breakdown of Annual Energy Load in a Commercial Office Building



Note: These percentages are an approximation only and would vary in an actual building according to its construction, its heating, ventilation and air conditioning system, and other factors.

Rising energy costs clearly justify increasing the amount of insulation in new buildings, using double glazing and designing physical characteristics to minimize infiltration.

In existing buildings, however, the cost of re-insulation may be too expensive unless it can be done at the same time as other major maintenance or renovation projects. For example, additional roof insulation can be installed at the same time as a tar-and-gravel roof is replaced. (Note that any re-insulation must comply with fire safety standards).

Determining the economic value of a re-insulation project for your building should be included in your building's energy audit. But even if re-insulation does not appear attractive, eliminating air leaks wherever possible is worthwhile. This includes weatherstripping at doors, windows, soffits, and so forth.

Ventilation

Air is mechanically taken into a building to provide fresh air. Depending on the air's temperature, this in turn requires additional energy for heating or cooling. Thus, to save energy, the critical question is how much fresh air is actually necessary?

Most existing buildings have systems which provide a predetermined minimum flow rate of fresh air. Usually this is set at about .007 to .009 cubic metres per second per occupant (equivalent to about 17 cubic feet per minute). These standards are based not on oxygen requirements, but on the need to dilute objectionable odours. The actual amount of ventilation required, therefore, depends more on the particular use of the space by people than on its size.

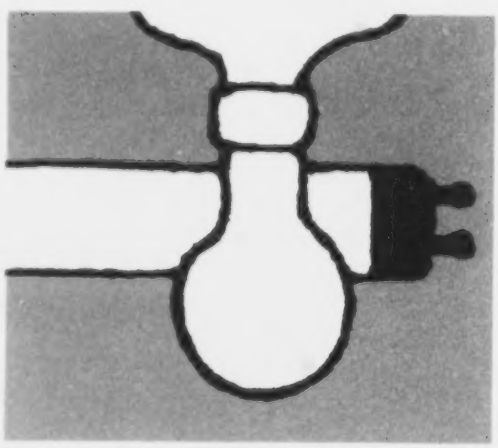
Recent studies have established that most commercial and office buildings in fact need only .0030 to .0035 cubic metres per second per occupant (equivalent to about 7 cubic feet per minute). Lowering fresh air intake rates to this level will reduce the energy required to heat or cool the outside air. And comfort is not sacrificed.

During night hours and weekends, fresh air intake can usually be shut down completely. If certain areas of the building are in constant use, they should be equipped with separate ventilation units.

Lighting

Lighting is the single largest user of energy in commercial buildings, both in energy used directly for illumination and in the secondary demand caused by the heating effect of lights. On average for the entire year, every watt of lighting requires more than another half watt of energy for cooling, pumps and fans.

Over the years, lighting standards in North America have steadily increased, until now they are often twice as high as in many European countries. The necessity for such high lighting levels is a subject of considerable debate. But in any case, the growing need to conserve energy suggests that it is time to concentrate on lighting quality rather than quantity.



Most existing office buildings have fully recessed fluorescent fixtures giving off an average of 100 foot-candles illumination. These buildings use an average of 42 watts of lighting per square metre (4 watts per square foot). In contrast, new buildings are designed – either with coffered ceilings or task lighting – so that they consume less than 20 watts per square metre and provide working areas with 70 foot-candles.

This more efficient lighting design also reduces cooling, pumping and fan loads. Together with the direct savings from reduced lighting, this translates into an impressive savings of 20 per cent of a building's *total* energy consumption.

While this extent of savings is not attainable in most existing buildings, lighting loads can be reduced by as much as a third by the following measures.

- Systematically remove or disconnect a portion of lighting fixtures in non-critical areas, such as lobbies, corridors and storage rooms. Light in these areas should be as low as safety and security will allow*
- A number of fixtures can also be disconnected in most working areas, depending on their arrangement and use.*
- Wherever possible, lighting should be reduced near windows. Separate circuits or dimmers are desirable in any areas where full illumination is only periodically necessary.*
- As tubes are replaced, use the newer types that reduce lighting intensity and power consumed by about 15 percent.
- Keep walls, ceilings and fixtures clean and choose colours that reflect light. Dark colours and dirt can reduce illumination by as much as 40 percent.
- Last but not least, turn off lights when rooms are not in use. Be sure that custodial staff remember to follow this rule when they finish their tasks.

*Note that fluorescent tubes must usually be removed in pairs. Consult a qualified electrical technician if you have any questions. Also, before reducing lighting levels, be sure to check the standards set by the Occupational Environment Branch of the B.C. Ministry of Labour and by the Workers' Compensation Board.

Other Loads

Heating water for domestic use is not one of the largest consumers of energy in a commercial building. But significant savings are possible by properly re-insulating all tanks and pipes. It is also recommended that hot water temperatures be lowered: for washrooms, for example, to no more than 40°C.

The other two energy loads in a building are office machines and equipment (primarily elevators) for moving people and goods. Energy savings in these areas depend more on people's attitudes than on physical or operational changes to existing buildings.

Many buildings, however, can save money (though not energy) by planning work schedules to use the least amount of equipment possible at any one time. Since electricity rates are made up of both an energy charge for the amount of energy actually used and a demand charge for the highest level of demand required at any one time, it pays to keep that peak demand as low as possible.

This will require a degree of tenant awareness and cooperation. But in fact your entire energy management program will benefit from widespread participation and understanding. Tenants greatly affect the amount of energy consumed by, for example, turning off equipment and lights and, indirectly, by a willingness to change their dress habits to accommodate higher summer and lower winter temperatures.

Improving Mechanical Systems

Heating, Ventilation and Air Conditioning Systems

To maintain reasonable comfort, the heating, ventilation and air conditioning (HVAC) system in a large commercial building must provide:

- Cooling year-round in interior areas to offset heat from lights, people and equipment.
- Year-round capability to heat and cool perimeter areas. South and west perimeter areas, for example, require cooling even in cold weather to offset the solar heat gained through the large glass areas of most buildings.
- Reasonable quantities of outside air for ventilation, and to make up for air lost through exhaust systems.

A variety of HVAC systems have been developed over the years. For the most part, they are relatively energy inefficient. The major problem is that these systems, in providing adequate comfort, often require simultaneous heating and cooling.

For example, one type of HVAC system commonly installed until recently is called the "constant volume terminal reheat system." This system supplies a constant volume of cool air to a series of offices or zones in a building. Simultaneously, when peak cooling is not required in any zone, a heating coil provides the reheat needed to maintain the desired temperature.

Today, new buildings are being outfitted with far more efficient HVAC systems. These eliminate wasteful simultaneous heating and cooling through a "variable volume system" that automatically regulates the volume of cool air taken into a building to match the cooling requirement. This reduces operating costs and heating and cooling requirements. In fact, it is now possible to design a large office building where all heating requirements are supplied by the heat generated by people, lights and equipment.

For some buildings, it may be economically and mechanically feasible to convert from an inefficient constant volume HVAC system to an efficient variable one. This potential improvement would be evaluated in the energy audit.

In most cases, however, a building will have to retain its existing HVAC system. Nevertheless, modifications for significantly improving an existing system's efficiency are still practical, and these should also be identified in the energy audit. For example:

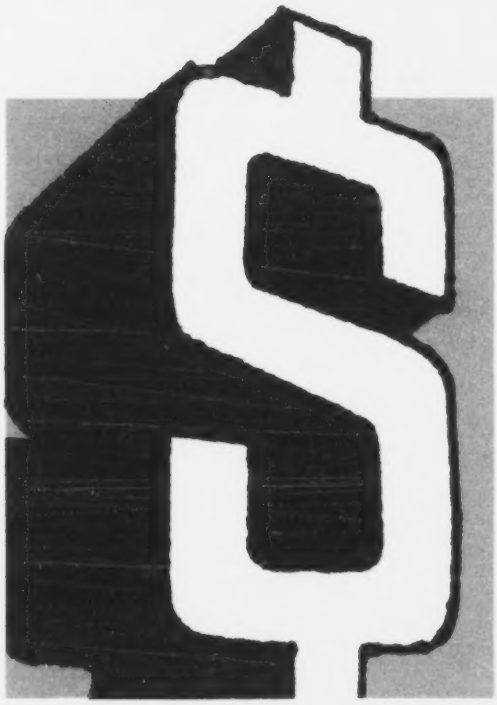
- The air supply temperature on a constant volume or dual-duct system can be modified so that it is controlled on a variable basis rather than at a pre-set constant temperature.
- The primary air supply temperature in an induction HVAC system may be warmer than required. This creates unnecessary simultaneous heating and cooling.
- The air balance should be checked in all HVAC systems to ensure that some building zones are not under-aired, which results in unnecessary re-heating in other zones.

Heat Recovery Systems

As stated earlier, the occupants, equipment and lighting in a building generate considerable heat. Properly tapped, this heat can provide part or all of a building's usual heating needs.

There are a number of systems for recovering and redirecting otherwise wasted heat. The one now in most common use is the heat pump.

Fairly sophisticated systems have been designed to use internal source heat pumps in large office buildings. These are particularly feasible when there is a fairly uniform and continuous heat source, such as a large computer installation. While heat pumps and other heat recovery systems (such as heat wheel and run-around coils) may not be economically feasible for most existing buildings, their potential application should nevertheless be evaluated in the energy audit.



Financing Energy Management

The capital investment required to retrofit an office building for energy efficiency can usually be paid back by the resulting savings in two years or less. After that, the continuing savings – larger each year as energy prices rise – will reduce a building's operating cost and make rents more competitive.

Most leases for tenant-occupied buildings have a form of base-year clause which might seem to block an owner's ability to finance the retrofit improvements. By the terms of this type of lease, increased (or decreased) operating expenses, such as energy, are simply passed through to the tenant. If an owner invested, say, $50,000 on a retrofit resulting in $30,000 of annual savings, he might not get a return on his investment. He would pay the capital cost, and his tenants would get the savings.

There is, however, at least one proven approach to overcome this barrier:

- The owner completes the type of energy audit described earlier. This audit shows specific conservation measures, their cost, annual savings, and pay-back period.
- The audit report then serves as the basis for a special owner/tenant agreement whereby:

1. The tenant agrees to pay for the same amount of energy that he is consuming in the current or base year for a period of one to three years, depending on the pay-back period indicated in the energy audit.
2. During that period, the energy savings accrued from the retrofit, instead of being passed through to the tenant, enables the owner to finance the cost of the retrofit.

This straightforward agreement is a clear benefit to the tenant because, in all likelihood, his energy payments without retrofit, would have risen appreciably during the one to three year period. With the agreement in force, his energy cost is stabilized; and afterwards, he profits from lower energy charges. And the owner gains a more efficient and more competitive building.

Owners can also take the initiative to promote a more immediate incentive for energy savings through the disconnection or removal of unnecessary light fixtures. Depending on its hours of use, the direct cost at current rates to operate one light fixture with two 40-watt tubes ranges between $8 and $10 per year. Tenants could receive an immediate discount for each light fixture they agree to have disconnected. This immediate reward for energy efficiency can be the beginning of a longer-term cooperative program that benefits everyone.

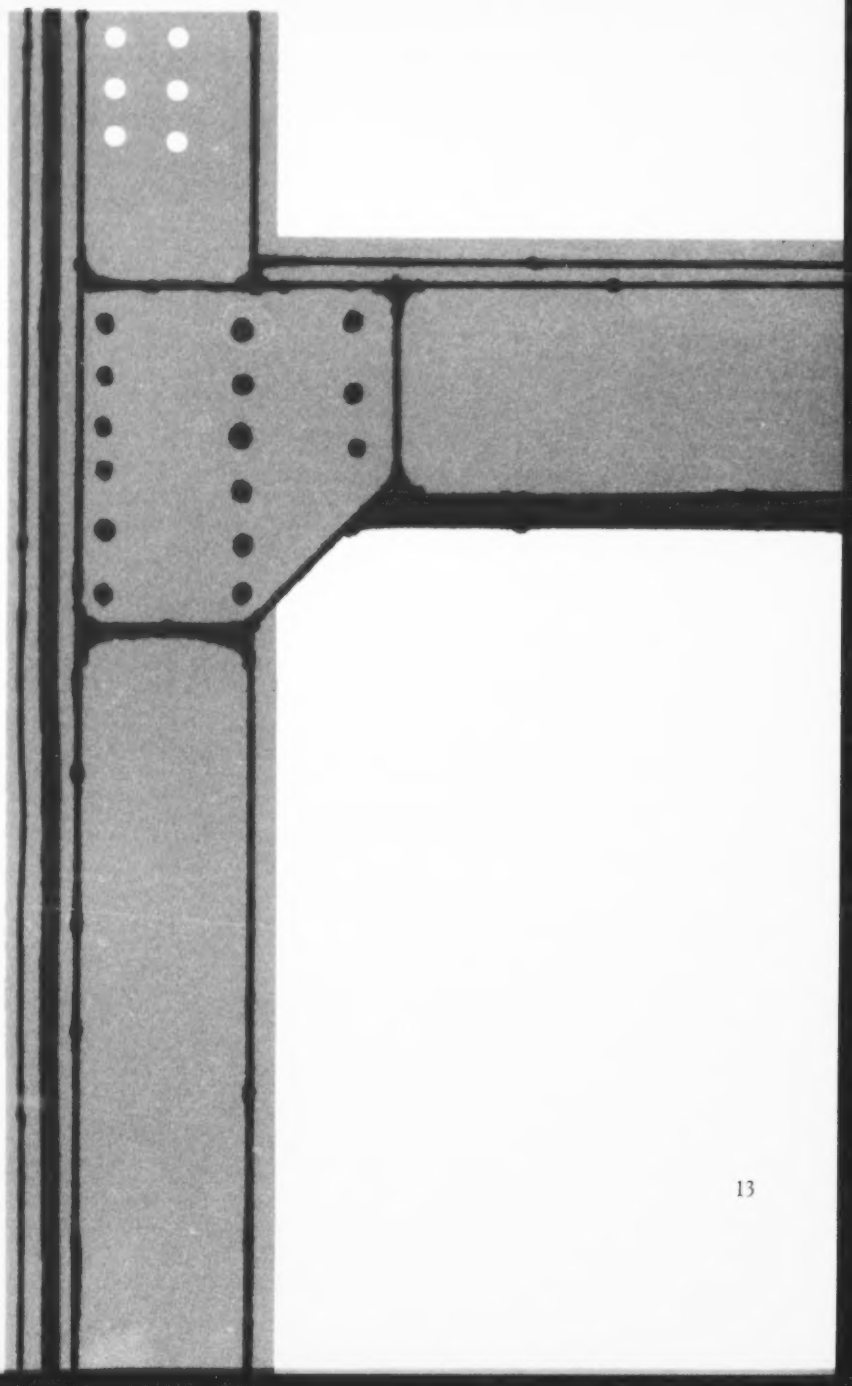
New Buildings

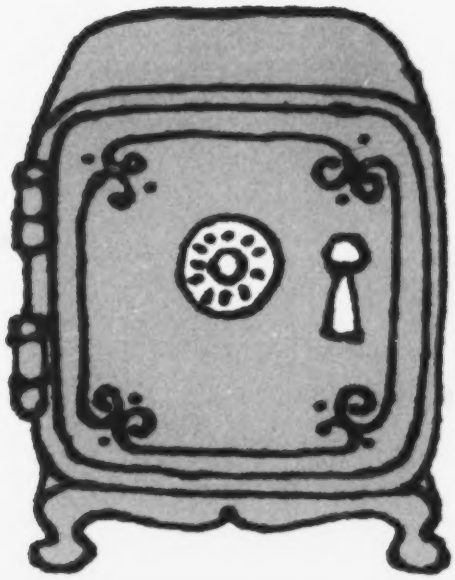
The precarious energy situation of the 1970's has stimulated whole new directions in building design. While it is not the purpose of this manual to examine energy efficient design for new buildings in detail, there have been references throughout about the energy-saving potential in new buildings and equipment. This has been useful for comparison, and to show what kind of competition lies ahead for existing buildings.

In summary, some of the basic approaches for energy efficiency in new air conditioned buildings are:

- The building is sealed by maximum insulation and minimum air leakage. Window area is minimized, and solar reflecting double glazing is used throughout.
- Lighting levels and the placement of fixtures are arranged appropriate to needs. Non-work areas have reduced lighting, and task lighting is used wherever possible.
- Mechanical and electrical systems (for lighting, heating, ventilation and air conditioning) are selected for durability and energy efficiency. Sophisticated automatic controls are employed to minimize energy consumption.
- Heat recovery systems, where practical, recycle ordinarily wasted heat from internal building sources, greatly reducing or eliminating the need for added space heating. Fresh air is used for cooling when possible.
- The shape, site and orientation of a building can take advantage of natural heating and cooling from the wind and sun.
- Fresh air ventilation is designed to ventilate in a cascading fashion; e.g. from work areas to washrooms to outside. Fresh air intake is kept to a comfortable minimum.
- From the start, energy efficiency plays a major role in the building's operation and maintenance program. Building personnel are educated in energy efficiency; and tenants, too, can usefully be familiarized with the building's features, and participate where possible.

This is a brief look at the ideal. To whatever degree is practical, existing buildings can profit from adopting similar measures and practices.





Costs

Some of the measures outlined above for new buildings require no net added capital cost. The cost of most of the others is justified by reduced annual operating expenses.

Even though some measures result in an increased cost, others result in decreased costs. Increased insulation may cost more but will permit a smaller heating unit; double glazing costs more, but smaller sized windows save money.

Some of the more innovative technology, however, may or may not be economically justified. The difficulty arises in weighing the first cost of a building against its "life cycle" cost.

As well as its initial capital cost, evaluating the real cost of a building should include the future costs for operation, replacing equipment, and energy **over the long-term.** The rapidly rising price of energy may justify a higher first investment in efficient design, construction and equipment than might at first appear economic.

Although it requires a little extra investigation, it is strongly recommended that developers and prospective owners employ life cycle methodology when planning their new buildings.

Certainly the principal lesson we are learning from our ongoing energy problems is that we must all begin to consider the future now.

Operation Checklist*

1. Ensure that operating personnel are familiar with equipment, installations, and distribution systems.

2. Make available pertinent drawings and operating instructions to operating personnel.

3. Develop schedules and instruct cleaners, guards, and other workmen to turn the lights on in the morning and off at night at predetermined times.

4. Schedule control and switching off of street area, perimeter, and floodlighting.

5. Determine the most economical use of snow-melting and heating-cable systems in accordance with weather conditions.

6. Investigate the possibility of rescheduling operations in order to decrease the peak loads on utilities.

7. Develop a building heating schedule to allow the most economical use (i.e. the most advantageous turning "on" and "off" points) of steam, hot water, and electric heating.

8. Investigate humidity systems for proper operation and adjustment.

9. Shut down motor-operated equipment whenever possible to reduce power consumption.

10. Shut down air-conditioning and ventilating systems (whenever possible) after working hours and during weekends and holidays.

11. Lower storage tank temperatures of domestic hot water heating systems to the point where the storage capacity is just sufficient to meet the occupancy requirements.

12. Check calibration of controls for air-conditioning systems and boilers to ensure the most effective performance.

13. Set back thermostat controls to 15°C (60°F) for night-time operation.

14. Place lamps to give the desired illumination at task stations and reduce lighting levels in non-essential areas.

15. Check that all plumbing fixtures are turned off when not in actual use.

16. Keep accurate records, properly tabulated and supplemented with graphs. They should include:
- consumption of fuels, water, and electricity;
- production of steam where steam is being generated;
- changes in operating procedures (e.g. changes in scheduling equipment shutdown, adjustments, etc.);
- inspections;
- modifications and improvements pertaining to energy savings and related installation costs.

The records should show changes in energy consumption resulting from the implementation of the energy-conservation program. An evaluation of savings should be based on the annual meteorological records. A summary of fuel and electricity consumption for each year should be prepared.

17. Monitor flue gases on a regular basis to ensure optimum combustion.

18. Develop specifications for new equipment to ensure that it is designed to use the minimum amount of energy within the requirements of performance, longevity, and maintenance.

19. Do not buy inexpensive and inferior equipment to save money on the initial cost. More often than not, inferior equipment consumes more fuel or electricity.

20. Consider installing monitoring devices on equipment that uses large amounts of energy. The monitoring device will sound an alarm or shut down improperly maintained equipment until the malfunctions are corrected.

21. Institute an educational program for operating staff relating to the conservation of energy. The program will need repeating as new techniques become available and also to train new personnel.

*Operation and Maintenance Checklists courtesy of Ontario Ministry of Energy.

APPENDIX

Maintenance Checklist

1. Establish a controlled preventive maintenance program.

2. Clean lighting fixtures and replace light bulbs and fluorescent tubes regularly.

3. Consider institution of group relamping programs.

4. Check air filters of ventilation and air-conditioning systems on a regular schedule.

5. Maintain equipment to allow operation at optimum efficiency.

6. Clean all equipment regularly.

7. Enter into maintenance contracts for specialized systems such as controls, refrigeration equipment, water treatment, etc.

8. Conduct combustion efficiency tests at regular intervals and make any necessary adjustments.

9. Weather-strip windows and door openings, caulk window and door frames. Storm window installation should be considered.

10. Provide insulation, where economically feasible, for roofs, walls, ceilings, and floors.

11. Seal all sky-lights and other roof openings as tightly as possible to reduce the "chimney-effect."

12. Improve insulation of steam mains, risers, runouts, etc. Add insulation to all uninsulated pipe fittings, flanges, and equipment.

13. Check radiation surfaces for obstructions.

14. Remove or shut off unused steam and return piping of steam distribution systems.

15. Check hydronic systems for the proper temperature difference between supply mains and return mains.

16. Examine air distribution ducts for leaks, deterioration, separation of insulation, heat pickup from pipes, and required insulation improvements.

17. Check insulation on refrigeration lines.

18. Install raw water make-up supply meters in boiler plants.

19. When replacing electrical fixtures, use more efficient fixtures wherever possible, taking into consideration the efficiency of lamp sources and fixture design.

20. Investigate and correct the power factor of the electrical distribution system.

21. When alterations are being made, evaluate the light reflectances of walls, floors, and ceilings to achieve more efficient light utilization.

22. Add automatic controls wherever possible to allow the most economical operation of equipment.

23. Install clocks, photo-cells, and other controls to ensure the predetermined cycle operation.

24. Revise electrical circuits to allow partial switching of electrical loads.

25. Add zone controls, day-night controls, mixing temperature controls, return controls, return-air temperature controls, etc., as required, to reduce energy consumption.

26. Investigate the feasibility of installing air-to-air and air-to-water heat-recovery equipment in systems requiring large volumes of outside air.

27. Consider having a competent combustion engineer make a flue gas analysis at least once a year to properly adjust the fuel input and to check combustion.

28. Institute educational programs relating to the conservation of energy for maintenance staff and encourage staff to attend Building Operation courses conducted at community college night schools.

29. Check all steam traps for size, type and leaks.

Form 1. Electrical Energy Consumption

Building Name: _____

Address: _____

Gross Floor Area: _____ m^2 Heating Fuel: Gas ☐ Oil ☐ Electricity ☐

Forced Air Ventilation: Yes ☐ No ☐ Air Conditioning: Yes ☐ No ☐ Partial ☐

Billing Date	Rate	Reading Period*		Consumption kWh	kW Demand		Power Factor	Cost	Unit Area Consumption kWh/m^2
		From	To		Meter	Billed			
ANNUAL TOTAL									

*Compute one complete year using past utility bills.

Note: 1 sq. ft. = .093 sq. meters.

Form 2. Oil Gas Energy Consumption

Building Name: _____

Address: _____

Gross Floor Area: _____ m^2 Heating Fuel: Oil ☐ Gas ☐ Electricity ☐

Forced Air Ventilation: Yes ☐ No ☐ Air Conditioning: Yes ☐ No ☐ Partial ☐

Billing Date	Rate & Fuel	Reading Period*		Total Oil Consumption		Total Gas Consumption		Total Cost	Unit Area Consumption (in kW equiv.) kWh/m^2
		From	To	Gals.	kWh	Therms	kWh		
ANNUAL TOTAL									

*Compute one complete year using past utility bills.

Note: One therm = 29.31 kWh
One gallon No. 2 oil = 48.94 kWh
One gallon propane = 34.28 kWh

Form 3. Total Energy Consumption

Building Name: _____

Address: _____

Gross Floor Area: _____ m^2 Heating Fuel: Gas ☐ Oil ☐ Electricity ☐

Forced Air Ventilation: Yes ☐ No ☐ Air Conditioning: Yes ☐ No ☐ Partial ☐

Reading Period		Energy Cost				Total Unit Area Consumption (in kW equiv.) kWh/m^2
From	To	Electrical	Oil	Total	$Cost/m^2$	

The Energy Bus Program

The Ministry of Energy, Mines and Petroleum Resources, in conjunction with Energy, Mines and Resources Canada, offers this free service to British Columbia's industrial, commercial, and institutional installations.

Industry uses half of all the energy consumed in this province; commercial operations and institutions consume another 12%. An effective way for these businesses to combat rising energy prices is to increase the energy efficiency of their operations.

How It Works:

At your request, a specially-trained team of engineers and technicians will come directly to your business site to conduct a computerized energy-use audit. This free and confidential service will provide managers with important data about their companies; total present energy consumption, future projected energy costs, and potential for cost reductions.

On the average the Energy Bus program, in its one-day visit, will identify savings of 15 to 20% of a client's total energy bill. Even more savings are possible. Managers are encouraged to implement a comprehensive conservation program, either with their own staff or with the aid of consultants.

Who Can Use It:

The audit service is designed for industrial and commercial firms and institutions whose energy consumption ranges between $10,000 and several million dollars per year.

Some typical businesses which have utilized the bus are:

- Sawmills
- Fish processing plants
- Plywood mills
- Dairies
- Bakeries
- Food processing plants
- Office buildings
- Shopping centres
- Hotels
- Foundries
- Wood products manufacturing
- Cement plants
- Machine shops
- Chemical manufacturing
- And others.

How You Can Get It:

Fill out this coupon and mail it to:

Energy Bus Program
2100 - 1177 West Hastings St.
Vancouver, B.C. V6E 2L7

and you will receive a kit which explains the program, or you can phone (604) 689-1831.

Name: _____

Address: _____

_____

Phone: _____